Real Time Space Radiation Effects in Electronic Systems

Completed Technology Project (2012 - 2013)

Project Introduction

The effects that solar particle events can have on operational electronic systems is a significant concern for all missions, but especially for those beyond Low Earth Orbit away from the protective effects of the Earth's magnetic field. This proposal will develop a system that is capable of quantitative short term forecasts for such events that will be a useful tool for making operational decisions for protection of our space assets. The capabilities developed will also have other applications in the design phase of spacecraft and for anomaly reviews.

The ability to predict the occurrence and magnitude of solar particle events (coronal mass ejections and solar flares) has been elusive so exposure of astronauts and flight electronics to this radiation is a serious concern for NASA. This work focuses on exposure of operational flight electronics to solar particle events, which can jeopardize human safety. The NOAA Space Weather Scale uses the terminology "Solar Radiation Storms" to describe solar particle events and categorizes the level of event severity on a scale from S1 (Minor) to S5 (Extreme). The size of these events spans orders of magnitude and therefore the resulting exposure to energetic particle radiation can cause a wide range of effects depending on the severity of the event. For an S1 level event the effect on satellite operations according to the NOAA scale would be "none" while for an S5 level event "satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible". The end result of this IRAD will be a quantitative "nowcasting" tool for solar storms with classification of the severity of the storm according to the NOAA Space Weather Scale for ease of interpretation by mission operations. This would be used by mission operations as input for making decisions on whether systems and instrumentation should be shut down during an event. These decisions would be driven by the particular features and susceptibilities of each spacecraft and its payload. FY13 will be dedicated to development and verification of the quantitative aspects of the model techniques. Short term predictions of solar storms will be verified based on space data taken by the GOES Space Environment Monitor (SEM) and the CRaTER instrument on the LRO spacecraft. The latter is in an approximately 50 km circular lunar orbit.

Anticipated Benefits

The real time forecasts of solar events will allow operational decisions to be made that save lifetime on electronic systems and instrumentation and help protect astronauts. In addition, none of the radiation environment models used for engineering purposes of spacecraft design were developed for operational usage. They are climatological (long-term) models used during the spacecraft design phase that do not include the dynamic aspects of the radiation environment. The tools developed in this work will also support the

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Table of Contents

Real Time Space Radiation Effects in Electronic Systems

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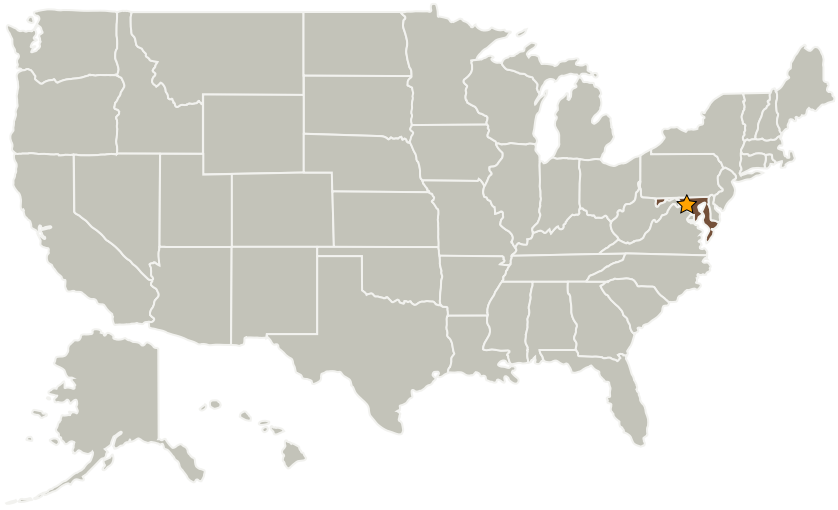
design phase of spacecraft by making available dynamic aspects of the environment to help improve the return of science data. These tools will also be a benefit for spacecraft anomaly reviews.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Website:

http://aetd.gsfc.nasa.gov/

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

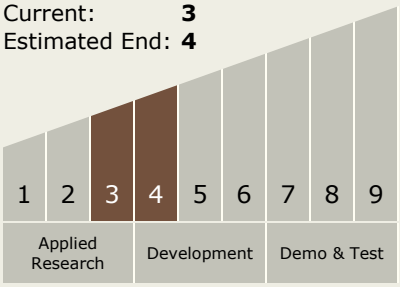
Wesley A Powell

Principal Investigator:

Michael A Xapsos

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



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Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.5 Radiation
    - TX06.5.4 Space Weather Prediction